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X. *Additional Remarks on the State in which Alcohol exists in fermented Liquors.* By William Thomas Brande, Esq. F.R.S.

Read December 17, 1812.

THE experiments and observations contained in this paper, are intended as supplementary to a communication on the same subject, which the Royal Society has done me the honour to insert in the Philosophical Transactions for the year 1811.\*

On that occasion, I endeavoured to refute the commonly received opinion respecting the *production* of alcohol during the distillation of fermented liquors, by shewing, that the results of the process are not affected by a variation of temperature equal to twenty degrees of FAHRENHEIT'S scale; that is, that a similar quantity of alcohol is afforded by distilling wine at 180° and at 200°.

I also conceived that any new arrangement of the ultimate elements of the wine, which could have given rise to the formation of alcohol, would have been attended with other symptoms of decomposition, that carbon would have been deposited, or carbonic acid evolved, which in the experiments alluded to, was not the case. Upon such grounds I ventured to conclude, that the relative quantity of alcohol in wines, might be estimated by submitting them to a careful distillation, and by ascertaining the specific gravity of the distilled liquor with the precautions which I have formerly described.

This conclusion may be objected to, by supposing that the lowest temperature, at which the distillations were performed, was sufficient for the formation of alcohol from the elements existing in the wine; but it is not easy to conceive how this should happen, without some of those other changes which I have just noticed.

It has been stated, in my former paper, that the separation of alcohol from wine, by the addition of subcarbonate of potash, is prevented by the combination of the alkaline salt with the colouring-extractive, and acid contained in the liquor. I have also shortly noticed some unsuccessful attempts to separate these substances by other means than distillation.

In prosecuting the inquiry, this difficulty has been surmounted, and I shall proceed to shew, that alcohol may be separated from wine without the intervention of heat, and that the proportion thus afforded is equal to that yielded by distillation.

When the acetate,\* or subacetate† of lead, or the subnitrate of tin‡ are added to wine, a dense insoluble precipitate is quickly formed, consisting of a combination of the metallic oxide, with the acid and colouring-extractive matter of the wine, and when this is separated by filtration, a colourless fluid is obtained, containing alcohol, water, and a portion of the acid of the metallic salt, provided the latter has not been added in excess, in which case a part remains undecomposed.

\* Sugar of lead.

† Formed by boiling two parts of sugar of lead with one of finely powdered litharge, in six parts of water. The solution should be preserved in well closed phials, as it is rapidly decomposed by attracting carbonic acid from the atmosphere. Even while hot, a portion of carbonate of lead is formed in it.

‡ Prepared by dissolving protoxide of tin in cold dilute nitric acid.

The acetate of lead and the subnitrate of tin produce the desired effect of separating the colouring and acid matters, in the greater number of instances, but they are less rapid and perfect in their action, and not so generally applicable as the subacetate of lead,\* which is the substance that I commonly employed.

The following experiment was made with a view to ascertain the effect of this salt.

Twenty measures of alcohol, specific gravity ,82500, were mixed with eighty measures of distilled water coloured with log wood, and rendered slightly acid by supertartrate of potash. Four measures of a concentrated solution of the subacetate of lead were added to this mixture, and the whole poured upon a filter. A precipitate was thus collected of a deep purple colour, which appeared to consist of oxide of lead combined with tartaric acid and the colouring-extractive matter.

The filtered liquor was perfectly transparent and colourless, and afforded, on the addition of subcarbonate of potash, 19,5 measures of alcohol.†

\* The effect of this salt upon colouring matter, was first pointed out to me by Mr. E. M. NOBLE of Chelsea.

† Pure subcarbonate of potash, obtained by igniting the carbonate, was employed in these experiments. I found that about 19,5 parts of alcohol were separated in the course of four hours, by the addition of 50 parts of the subcarbonate to a mixture of 20 parts of alcohol by measure with 80 of distilled water, and that no further separation took place. The alcohol is always slightly alkaline, probably from containing a small portion of the solution of the subcarbonate, or of pure soda, but as this did not interfere with the object of the experiment, it was not particularly attended to.

When the subcarbonate was added to a mixture of four parts by measure of alcohol with 96 of water, no separation was effected.—A mixture containing 8 per cent. of alcohol afforded about 7 parts—one containing 16 per cent. about 15,5, and where the proportion of alcohol exceeded 16 per cent. the quantity, indicated by the action

Finding that the separation of alcohol by subcarbonate of potash from mixtures of spirit and water, was nearly complete, and that colouring-extractive matter, and tartaric acid might be removed from such mixtures by the subacetate of lead, I proceeded to examine wine by such modes of analysis.

The following results were obtained by these, and other comparative experiments.

1. One part by measure of a concentrated solution of subacetate of lead, was added to eight measures of common port wine: the mixture having been agitated for a few minutes, was poured upon a filter.—The filtrated liquor was perfectly colourless, and the addition of dry subcarbonate of potash effected a rapid separation of alcohol.\*

100 measures of the wine thus treated, afforded 22,5 measures of alcohol.

2. Eight ounces of the wine employed in the last experiment, were distilled in glass vessels, as described in my former paper.—The specific gravity of the distilled liquor at the temperature of 60° was 0,97530, which indicates 22,30 per cent. by measure of alcohol of the specific gravity of ,8250.

3. Eight ounces of the same wine were introduced into a retort placed in a sand heat, and the process of distillation was stopped when six ounces had passed over into the receiver.

of the subcarbonate, was always within 0,5 per cent. of the real proportion contained in the mixture. So that in the examination of wines containing less than 12 per cent. of alcohol, the method described in the text is somewhat exceptionable. The above experiments were made in glass tubes varying in diameter from 0,5 inch to 2 inches, and accurately graduated into 100 parts.

\* When any excess of the subacetate had been employed, a portion of carbonate of lead was thrown down; but this did not interfere with the subsequent separation of the alcohol.

After the vessels were completely cooled, the portion in the receiver was added to the residuum in the retort. The specific gravity of this mixture (ascertained with proper precautions) was ,9884, that of the original wine = 0,9883.\*

When care was taken to prevent the escape of vapour, no change of specific gravity was produced in the wine by three repetitions of the above process.

Similar experiments were repeated upon Madeira, Sherry, Claret, and Vin de grave, wines differing in the relative proportions of alcohol, colouring matter, and acid which they contain, and the results were as decisive; so that I conceive it is amply proved, by experimental evidence, that no alcohol is *formed* during the distillation of wines, and that the whole quantity found, after distillation, pre-existed in the fermented liquor.

It has been frequently asserted, that a mixture of alcohol and water, in the proportions I have stated them to exist in wine, would be much more effectual in producing intoxication, and the general bad effects of spirituous liquors, than a similar quantity of the wine itself. But this is true to a very limited extent only: when brandy is added to water, it is some time before the two liquids perfectly combine, and with alcohol this is more remarkably the case, and these mixtures are warmer to the taste, and more heating, if taken in this state of imperfect union, than when sufficient time has been allowed for their perfect mutual penetration.

I have also ascertained that distilled port wine tastes stronger, and is more heating than the wine in its original state, and that these qualities are impaired, and the wine reduced nearly

\* This experiment was suggested in the *Edinburgh Review* for November, 1811.

to its original flavour, by the addition of its acid and extractive matter. With claret, and some other wines, containing less alcohol and more acid than port, these circumstances are more readily perceived; and lastly, if the residuum afforded by the distillation of 100 parts of port wine, be added to 22 parts of alcohol and 88 of water (in a state of perfect combination), the mixture is precisely analogous in its intoxicating effects to port wine of an equal strength.

In the table annexed to my former paper, it appears that the average quantity of alcohol contained in port wine amounts to 23.48 per cent.; but two of the wines there alluded to are stronger than any I have since met with, and were, at that time, sent to me as "remarkably strong and old port." I have lately examined a number of specimens of the better kinds of port wine in common use, and the results of these experiments lead me to place the average strength at 22 per cent. of alcohol by measure.

A port wine procured for me by Dr. BAILLIE, and to which no brandy had been added, afforded 21.40 per cent. of alcohol: another specimen of a similar description, put into my hands by an Oporto merchant, contained only 19 per cent.; it is the weakest port wine I have met with.

The other results given in the table, agree perfectly with those of subsequent and more extended experiments.